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Professor Watt

The central figure associated with the Silver Jubilee of the Sydney University Faculty of Agriculture celebrated last month was Robert Dickie Watt, who has the distinction of being not only the first occupant of the Chair at Sydney but also the first Professor of Agriculture in any Australian University. The responsibilities falling to his lot in 1910 when he entered upon what was to be his life's work, doubtless caused him the deep concern shared by any young man of twenty-nine years about to take up a new and responsible position. But in recommending Robert Watt for the new Chair, the selection committee in London did so with unanimity and confidence for he had completed brilliant courses of study at the West of Scotland Agricultural College, the Scottish Dairy Institute and the University of Glasgow, and had obtained with high honours the academic distinctions, M.A., B.Sc., N.D.A., N.D.D. Moreover, he had held the Carnegie Research Scholarship at Rothamsted for two years, and had achieved distinction as Chief Chemist in the Transvaal Department of Agriculture. The wisdom and foresight displayed by the selection committee in making the choice have been the subject of comment on more than one occasion; this, in fact, was the keynote of most of the congratulatory messages

received last month from numerous agricultural research institutes, scientific societies and farmers' organisations throughout the world and read at the Jubilee Reception in the Great Hall on August 26.

The curriculum in agriculture at Sydney has been modelled on the standards of the leading seats of learning in Great Britain, and adapted to suit Australian requirements. The broad nature of the training provided in subjects of pure and applied science, together with the one year's practical farm work, has given to all students of the School a background fitting them for each and all of the many spheres of work included in agricultural science. The number of graduates to date totals 119, of whom 6 hold the degree of Doctor and 15 the degree of Master, while several also are holders of diplomas in applied science, education, agriculture and dairying from various institutions.

Professor Watt has been closely and actively associated with several important agricultural developments in Australia, and in addition to holding executive positions in a number of scientific societies has been Chairman of the State Committee of the Commonwealth Council for Scientific and Industrial Research since its formation, and is a member of the University Senate. But his contribution to the progress of agriculture in Australia has been mainly through the able manner in which he has discharged his responsibilities as Dean of the Faculty at Sydney. This has involved something more than the organisation of a curriculum, lecturing, the selection of suitable teachers for the various subjects, and attention to administration of his Department. If he had done no more than fulfil these obligations, his tenure of the Chair could be said to be distinguished. But his breadth of outlook—attributable in large measure to the wide background of experience in rural life, sport, academic life, research and administration obtained in early years in the United Kingdom and South Africa —has been the means of encouraging in all his students an interest in the many different phases of activity offering within a university, and an appreciation of what a university education really stands for. At all times he has taken a long view of the problems connected with Australian agriculture, and while inevitably the courses of study have laid emphasis on the necessity for specialisation, the teaching has not been lacking in stressing the need for cultivating a broad outlook. This influence has had its effect on all who have graduated.

The outbreak of war in 1914 caused almost every eligible student and graduate to enlist, and their record is one of which the School shall always be proud. In civil life, the graduates have made worthy, and in many instances outstanding contributions to science and to the solution of economic problems in Australia, and with these developments has arisen a wider and more enthusiastic appreciation of the need for scientific method in all phases of primary production. It must be with a deep sense of satisfaction that the Professor

counts among his graduates three Rhodes Scholars, the Professor of Agriculture in Queensland, the Professor of Biometry at Minnesota, the Principals of Hawkesbury, Roseworthy and Gatton Agricultural Colleges, the Lecturer in Plant Pathology and Genetics at Sydney, six other University lecturers, two lecturers at Teachers' Training Colleges, the N.S.W. Director of Plant Breeding, the Chief Biologist of the N.S.W. Department, the Headmaster of Yanco Agricultural High School, the Senior Geneticist of the C.S.I.R., the Economic Botanist of the Mandated Territory of New Guinea, the Chief Commonwealth Soil Surveyor, and the Chief Plant Pathologist in Western Australia,—to mention only some of those who occupy important positions in the agricultural world. Several of the graduates have benefited by research and contacts in overseas countries through the benefactions of the Rhodes Trust, Walter and Eliza Hall Trust, Ben Fuller Trust, Farrer Trust, Rockefeller Foundation, State Dept. of Agriculture, and the C.S.I.R., and in all cases the splendid achievements have directly reflected on the soundness of the undergraduate training instituted by Professor Watt in 1910 and subsequently changed according to requirements.

At all times the Professor has freely acknowledged the excellent assistance rendered by his staff of lecturers and demonstrators who along with strenuous teaching duties have devoted considerable time to the investigation of problems of importance in agriculture in this country, facilities for which have been generously provided by the Commonwealth Bank, State Dept. of Agriculture, the C.S.I.R. Endowment Fund and the Metropolitan Meat Industry Commission.

The N.S.W Barberry Proclamation

The publication in the New South Wales Government Gazette for July 12, 1935, of a proclamation requiring "every owner and every occupier of land throughout the State to destroy every plant known as Common Barberry (Berberis vulgaris) growing upon such land, for the prevention of the spread of the disease known as Puccinia graminis (rust in wheat)," represents the first legislative action taken by any State to cope with the potential menace of barberries in Australia. It was the outcome of but one phase of the vigorous plan of action which was initiated by the State Dept. of Agriculture in May of last year and which included wide publicity through the press, broadcasting stations, agricultural journals and conferences of growers as to the harmful nature of this exotic shrub. The need for all this became apparent when Dr. W. L. Waterhouse contributed a paper to the Linnean Society of N.S.W. in March, 1934, dealing with the first natural occurrence of wheat rust on barberries observed in this country, although as far back as 1921 he stated that "the distri-

bution of barberry plants should be discontinued" as experiments had demonstrated that under artificial conditions at least, Australian wheat rust was capable of infecting the alternate host, a fact not previously recognised.

It is common knowledge that the relationship between wheat stem rust and the barberry was proved by De Bary in 1865, although for centuries before this the relationship was so strongly suspected by farmers in Europe and America that laws were instituted for the extermination of the shrub,—and it is recorded that the first law passed for the elimination of this pest plant was in Rouen, France, in 1660. The work of the Federal Eradication Campaign instituted in the United States in 1918, and still in progress, is the outstanding example of the vigorous manner in which foreign countries have attacked the problem. In an official report issued last year it was stated that 6,000,000 common barberry bushes had been eradicated in Michigan and twelve other north-central grain-producing States in America since the Campaign commenced, and that while the annual cost was less than 300,000 dollars the savings to growers through diminution of wheat rust had amounted to 20,000,000 dollars each year in the thirteen States concerned. The total number of bushes destroyed in all States within the eradication area, of course, runs into many millions.

Admittedly the situation in Australia is not likely to be nearly as acute as it has been in the Northern Hemisphere where climatic conditions are more suited for growth of the shrub, but the plant is present here and the fact that new physiologic strains of the rust fungus originate on the barberry—a point established by Dr. Waterhouse in 1929—places an altogether new aspect on the menace of the alternate host which until comparatively recently had been considered mainly as a carrier of wheat rust. Plant pathologists are agreed that the early widespread occurrence of barberries in North America accounts for the existence of the 100 or more rust forms in that country, and significance is attached to the fact that only 8 rust strains have been recorded in Australia where the shrub is not widely distributed. The problem of developing wheat varieties resistant to several forms of *Puccinia graminis* is obviously more complex than where only a limited number of forms are involved, and Australia's position in this regard is at present relatively satisfactory. At the same time, the most widespread wheat rust strain in this Continent is the virulent "34" which is heterozygous and which in infection tests on the barberry at Sydney University has given rise to another virulent form, No. 11. Of still greater importance, however, is the recent announcement by Dr. Waterhouse of his discovery of form 11 on graminaceous hosts from three localities in New South Wales,—and this so soon after the first discovery of natural barberry infections in this country when, it is to be noted, 34 was the form isolated.

The need for a widespread, vigorous campaign of action throughout Australia therefore becomes all the more important. In the light of present information, each individual bush should be regarded as potentially dangerous,

particularly in view of the readiness with which seeds of the shrub may be disseminated by birds to out-of-the-way places where eradication would be difficult. Other countries' experience of the problem points the way to what the attitude should be in Australia. The matter is one of importance directly affecting the interests of wheat growers and plant breeders alike, and we hope that the time is not far distant when other States of the Commonwealth will see fit to initiate action similar to that recently adopted in New South Wales.

Australian Tobacco Problems

Summary by Dr. B. T. Dickson, Chief, Division of Plant Industry, Council for Scientific and Industrial Research, of discussions at the recent Tobacco Conference held at Canberra, F.C.T.

The first conference of departmental technical officers concerned with tobacco since the authorisation of the recent Commonwealth grant, was held at Canberra on 16th and 17th of July. Delegates from all States and the Commonwealth, were present as follows:—

Commonwealth—Dr. B. T. Dickson, Chief, Division of Plant Industry, C.S.I.R. (Chairman).

New South Wales—Mr. C. J. Tregenna, Tobacco Expert.

Victoria—Mr. S. Fish, Biologist; Mr. W. J. B. McDonald, Inspector of Agriculture.

Queensland—Mr. A. E. Gibson, Director of Agriculture.

South Australia—Mr. R. E. Courthope-Giles, Tobacco Officer.

Western Australia—Mr. H. A. Pittman, Plant Pathologist; Mr. A. Sharp, Agricultural Adviser.

Tasmania—Mr. D. H. Malcolm, District Agricultural Officer.

Certain other officers were present as observers.

The conference was opened by the Chairman, Dr. B. T. Dickson, who read a statement from the Minister, Senator Hon. A. J. McLachlan.

The chairman drew attention to the arrangement agreed to by the Standing Committee on Agriculture concerning responsibilities of Commonwealth and States. In brief, the Commonwealth is to conduct research into diseases, including work on disease resistant varieties, and is to carry out tests of smoking quality. The States are responsible for field investigations, instructional and demonstrational work and the supplying of samples for tests of smoking quality.

The conference spent practically all the first day discussing means of controlling downy mildew, better known as blue mould. It has been observed on wild tobaccos in Queensland, New South Wales, Victoria and Western Aus-

tralia, and the prevalence of these plants in the dry inland districts of Australia was pointed out. The possibility of disease on such plants militates against the successful establishment of seedling nurseries in dry areas.

Officers of the Queensland Department of Agriculture have had very successful results with the use of colloidal copper and copper emulsion sprays. These were tried out at Ashford, Deniliquin and Wangaratta by the C.S.I.R. and at Shepparton by the Victorian Department. The results were not as encouraging as those obtained under Queensland conditions.

Further spraying experiments using these materials will be carried out during the coming season by all States with the possible exception of Tasmania.

The C.S.I.R. reported on the experiments, initiated by Dr. H. R. Angell, Senior Pathologist, on the control of the disease by the use of hydrocarbon vapours, particularly that of benzol, in frame seedbeds. The results of these experiments were so encouraging and definite that all States plan to collaborate with the Council in the forthcoming season's trial of this method. It was emphasised that no experiments had yet been carried out in tobacco areas in spring and until that was done, the method would not be recommended for commercial application.

The development of varieties resistant to downy mildew is a C.S.I.R. responsibility, although some work has been undertaken by New South Wales and by an officer in the Queensland Department of Agriculture. The results to date are not promising and it was reported to the conference that a plan for C.S.I.R. to conduct a search for new types, possibly resistant to the disease, in Central and South America, the home of tobacco, had been approved by the Council of Agriculture.

Reports were submitted dealing with successful measures for the control of frog-eye leaf spot in North and Central Queensland. Other problems, particularly virus diseases and field dwarfing, were generally discussed and listed for early study.

The Director of Agriculture for Queensland, Mr. A. E. Gibson, announced that satisfactory results had been attained by members of Mr. Veitch's staff in the control of leaf miner and stem borer, insect pests which are common in tobacco areas.

The second day was spent in discussing problems associated with quality, field experimentation and methods of securing exchange of data and information.

A report on the chemical investigations into tobacco quality was presented by the chairman on behalf of Professor J. C. Earl, of Sydney University. The objects of these investigations are to determine the constituents of smoke which are desirable or objectionable, to ascertain what leaf constituents give rise to them and how to control their occurrence in the leaf. Analyses of smoke from low quality leaf gave an alkaline reaction, showed a higher content of tarry products, and sometimes also the presence of hydrogen sulphide. In the leaf,

the balance between nitrogen and organic acids seems to determine quality. During flue-curing, there is a loss of up to 25 per cent. of solids other than those containing nitrogen. It is concluded that the flue-curing of immature leaf anchors an excessive amount of nitrogenous substances in the leaf, and although these substances may be changed during curing they are not removed.

The principal points to be observed in collecting district samples for smoking tests were agreed to, and the conference approved the proposal to undertake the testing of referee smoking samples prepared to a standard by C.S.I.R.

The necessity for restricting tobacco culture to the most suitable areas was again stressed. It was regarded as almost impracticable at the present time actually to map areas, but it was held to be a development which will have to take place in the near future.

Curing experiments by C.S.I.R. were reported as having shown that the inferior heavy and immature leaf can be improved in smoking quality by lengthening the early stages of the curing process.

The conference discussed the question of quality and colour of tobacco, and it was generally agreed that colour was not a fully reliable criterion in deciding the smoking quality.

A noteworthy feature was the free interchange of data and experiences in all problems, particularly in fertiliser, cultural, and harvesting practices, field experimentation, varieties and so forth. In this connection C.S.I.R. was asked to act as a clearing house for information, and it was decided to supply the Division of Plant Industry quarterly with brief notes on crop conditions, disease incidence, progress of work, etc.

The resolution which brought to a close the first meeting of technical officers engaged in tobacco investigations in the States, reads—

> "In concluding this meeting, we unanimously affirm our intention to co-operate to the fullest extent in dealing with the various problems which beset the tobacco industry in Australia. We also desire to express the view that the results recently obtained by the Council for Scientific and Industrial Research on the control of blue mould encourage the belief that the solution of this problem may be encompassed within a foreseeable period. If this can be accomplished there are grounds for believing that it should be possible to establish the tobacco industry in Australia on a more stable basis, capable of maintaining continuity of production at a rate substantially in excess of that which obtains to-day."

Experimental Method

APPLICATIONS OF THE ANALYSIS OF VARIANCE IN EXPERIMENTAL ARRANGEMENT

by

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It is said that in many fields of agricultural endeavour, some of the most important research to be conducted is that having to do with the methods of conducting research. Particularly has this been true in the last decade during which an entirely new experimental technique has been developed which is consonant both with practical and theoretical requirements and which, properly employed, offers marked advantages both in ease of execution and in reduction of experimental error. It has become possible, furthermore, readily to extend the scope of experimental comparisons and, as a result, the much worn dictum that in agricultural experiments one must confine oneself to one single aspect of a problem at a time, has lost much of its force and is gradually losing its following.

In the "exact" sciences it is convenient and usually essential to discover how the experimental variant behaves with only one reacting factor varied at a time, i.e., under perfectly controlled conditions, and the workers in these sciences have been fortunate that such specific delimited experimentation is the end-point of their research. In agriculture, however, the position is entirely a different one. The plants or animals with which we deal are the resultants of many forces which cannot be controlled in practice; they are themselves inherently variable, and are subject to the influences of many other uncontrolled variables such as soils, manures, climatic factors, management, etc. For these reasons, the results which we obtain frequently do not hold good when applied to different varieties of the same crop, or even to different strains or individuals of the same variety on the one hand; or, on the other, to homologous individuals when one or more of the conditions of the environment are varied.

Biological experiments can rarely be reduced to a simple addition and subtraction, or to examination of behaviour under controlled conditions, because in a controlled experiment it is only in exceptional cases that modifications arising from the incidence of uncontrolled inherent or environmental factors do not, in practice, alter the reaction observed. The concentration on one aspect of a problem leaves us in ignorance of the interrelation and interreaction between

the variable under consideration and the uncontrolled or unconsidered variables which inevitably occur in the environment. Granted that, where there is no differential effect due to interaction, single factor experiments under controlled conditions are satisfactory; we must still remember that such observations are not capable of giving the necessary information as to whether ancillary factors do or do not exert any real differential effect; otherwise our experiments must frequently leave us open to mistaken generalisations. From the outset, much experimentation of this type is a mere collecting of facts which cannot conceivably be of benefit either to agriculture or to science.

It is true in many cases that we do not even require to know how our variables behave under controlled conditions; our interest is rather in what their behaviour is over the range of environmental variation to which our results must apply. We are obliged, in any case, to attack our problems with the realisation that many factors are uncontrollable and that we need to know as much regarding the magnitude of the interactions with some of these uncontrolled variables as we do of the action of the experimentally controlled variables on the variant under consideration. In other words, since uniformity of material and environment can never be attained when the result of our work is put into practice and since our results must survive these inevitable variations, we must, therefore, measure the effect of pertinent uncontrolled variables on and in comparison with our experimental variables. Fisher (8) has written in this connection, but from a different aspect, "No aphorism is more frequently repeated in connection with field trials, than that we must ask Nature few questions, or ideally, one question at a time. The writer is convinced that this view is wholly mistaken. Nature, he suggests, will best respond to a logical and carefully thought out questionnaire; indeed, if we ask her a single question, she will often refuse to answer until some other topic has been discussed."

Fisher developed the statistical method of Analysis of Variance (9) in 1919. An algebraic consideration of the method has been given by Irwin (16). Fisher's "variance" is a measure of variation. It is the sum of the squared deviations from the mean divided by the appropriate "degrees of freedom" which are obtained by subtracting from the total number of observations the number of constants, derived from the observations themselves, which have been used in calculating the deviations. The method of analysis renders possible in conformably designed experiments the separation of the total variance into parts appropriate to the several factors contributing to the total variation, the estimation of these individual variances, and their valid comparison by means of Fisher's "z test." It becomes possible, as a result, to include several factors in an experiment, to estimate the amount of the total variation contributed by each factor, to make an accurate and valid estimate of its significance, and, furthermore, to eliminate the variance due to ancillary factors in the calculation of the experimental error. From this advance in statistical method, arises in

experimental arrangement the application of the principle which Fisher has termed "local control" and which consists essentially in having one of the replicates of each treatment compared under one set of conditions, another replicate of each treatment under another set of conditions, and so forth. A simple application of the principle will be found in the manner of overcoming soil heterogeneity in "Randomised Block" and "Latin Square" field experiments.

RANDOMISED BLOCKS; LATIN SQUARES.

In variety trials in which the Randomised Block layout is adopted, the area of land available is divided into compact blocks or strips in each of which one plot of each of the varieties to be tested is included, the plot arrangement within each block being wholly at random; such an arrangement, for example, as ACDB, CBAD, DBCA, CDAB. Numerous uniformity trials have demonstrated that soil fertility variations are not distributed at random, but to some extent systematically, so that neighbouring plots are on the average more alike than those further apart. Consequently, the use of the Randomised Block technique allows, in each block, the comparison of each variety with the remaining varieties under conditions of comparable soil fertility. Difference in fertility between different blocks is of no moment since each plot occurs once within every block, and the average yields of the several plots of each variety are derived from plots subject to parallel conditions and are, therefore, strictly comparable provided there is no differential interaction due to block differences.

The application of the Analysis of Variance to the results of such an experiment allows the separation of the total variance of the experiment into three parts; one due to varietal differences, one due to soil and other inequalities between blocks as a whole, and a third due to random "error" remaining after allowance has been made for block and variety effects as a whole. It is then possible to compare the magnitude of the varietal effect with that of the random variations existent in the experiment by comparing their variances. The general significance of varietal differences must be tested in this way before the standard deviation of the experiment can be calculated. The significance of block effects versus random variation may be tested in the same way, as also may that of block effects versus varietal effects, and, whilst these comparisons are rarely of interest in variety trials, they are of considerable importance in other types of Randomised Block experiments as will be seen later.

The standard deviation is based on all plots in the experiment and is simply the square root of the random or error variance. It is to be noted that the use of the analysis of variance reduces the experimental error both by basing its calculation on the error of all the plots and by the actual elimination in the analysis of that part of the total variance which is due to differences arising from variation in soil fertility, or other factors, between blocks as a whole. The amount of soil heterogeneity variance removed by block differences depends on

the interrelation of plot size with block size and the type of soil heterogeneity encountered. It is convenient to calculate from the standard error and Fisher's table of "t" values, termed "significant differences," so that in comparing the means of any two varieties these differences in yield would be exceeded by chance only once in 20, 50, or 100 trials, whichever is the level of significance chosen.

The Latin Square arrangement allows the introduction of a further element of local control. Experiments can only be designed in this way when there are the same number of varieties as of replicates and the difference, for example, between the arrangement of 4 varieties in 4 Randomised Blocks and their arrangement in a 4 x 4 Latin Square lies in the fact that each variety is made to occur, not only once in each "row" ("block" of the Randomised Block arrangement), but also once and once only in each "column." Thus both columns and rows may be regarded as Randomised Blocks. Such an arrangement might be, for example, CDAB, BADC, ABCD, DCBA. The means of all varieties are again directly comparable and it is possible, as a result of this technique, to eliminate not only the soil heterogeneity between different rows (blocks), but also that between different columns, and thereby still further to reduce the experimental error.

It will readily be appreciated that the efficiency of such experiments is very largely dependent on the skill and judgment one displays in so selecting and subdividing the land available that within blocks, or rows and columns, the plots are on relatively uniform soil and that the major portion of the soil heterogeneity occurs between blocks, or rows and columns, and can subsequently be eliminated in calculation of the standard error. As a general rule, therefore, the blocks of a Randomised Block experiment are best arranged so that they are elongated across the fertility gradient, and the individual plots parallel to it. The choice of shape and size of plot and the number of replications to be used for variety trials of a particular crop is to be determined by several factors such as type of crop, convenience in sowing, working, harvesting, etc.; material and land available; degree of precision required; variability of material; heterogeneity of soil, etc., which cannot be elaborated here. The square plot has the advantage that in it, the edge effect is at a minimum, but for some crops the long plot often has practical advantages. Statistically, the latter has no advantages except where the direction of general fertility trend is known. It is an advantage to have the experiment as compact as possible, but the blocks, rows, or columns need not be absolutely contiguous and may be arranged either one beneath the other, or end to end in order to fit in with the area of land available. It is to be noted that in field experiments the Latin Square layout is usually much more efficient than is the Randomised Block arrangement. In some types of experiment, however, in which it so happens that a small proportion only of the total variance is eliminated by either rows or columns, the differences necessary for significance

may actually be increased by adoption of the Latin Square layout because of the consequent reduction in random degrees of freedom. Judicious arrangement of experimental detail can very considerably reduce the experimental error and enable the demonstration of the desired order of difference with less labour and expense, but whatever the plot size, shape or arrangement chosen, mistaken conclusions cannot be made if the experiment is properly designed and analysed.

Excellent detailed explanations of the Randomised Block and Latin Square layouts together with clear examples of the mathematical procedure involved in analysis of the results have been given by Fisher (8), Fisher & Wishart (10), Wishart (22), Maskell (18), Hoblyn (14), "Student" (20), Goulden (12), Forster & Vasey (11), and others. They have made it clear that in order to satisfy statistical requirements, the plot arrangement within the specific modification of each design must be decided at random. The positions of plots in each block of Randomised Block experiments are decided by some such simple method as drawing from a hat. In the case of Latin Squares, the plot arrangement is determined (10) by selecting at random one from all the possible Latin Square arrangements. Thus for a 4 x 4 Latin Square, there are 576 possible layouts, for a 5 x 5 Latin Square 161,280, and so on. The selection of 5 x 5 and 6 x 6 Latin Squares has been discussed by Yates (24).

In such experiments the diminution of experimental error can be carried to any degree of precision required, if land and other facilities are available, by increasing the number of replications since the random error is governed wholly by soil heterogeneity within blocks (or rows and columns) and the heterogeneity between blocks is eliminated in the analysis. The former has no tendency to increase as replications are increased, and the standard error is reduced in proportion to the square root of the number of replications.

Repetition of experiments is of value in testing conclusions reached for a single experiment over a variety of soil and climatic conditions, and over more than one season. If the same experiment be repeated over different seasons or in different places and comparable variability exists within the separate experiments, the data can be analysed as a composite whole and the mean differences tested against a standard error including differential variation due to season or place. The individual experiments should be separately randomised. McMillan & Bryan (19) have reported maize variety trials over several seasons in Queensland combined in this way, and Lewis et al. (17) have indicated the value of multiple 3 x 3 and 4 x 4 Latin Square manurial experiments conducted in different parts of Britain, Portugal and Canada.

COMPLEX EXPERIMENTATION.

It will be evident that the above types of layout apply equally as well to other kinds of field experiments as to variety trials. If we now consider manurial experiments as an example, we shall be able to follow a further advance which is made possible by application of the Analysis of Variance.

Manurial trials in the past have been largely confined either to comparison of different rates of application of a single manure or to comparison of empirically chosen combinations of manures. All such experiments can now be conducted to advantage in Randomised Blocks or Latin Squares. It is obvious, however, that much of the work done in quantitative comparisons of one fertiliser alone must be very largely wasted because they take account only of a single component affecting plant development, and disregard the concomitant interrelation of other fertilisers with the one under consideration. We need to have, with each particular crop, some general knowledge of which of the principal fertiliser constituents are most important, and of the balance between them which will yield best results.

In survey work of this type, the use of different rates of application of two manures in all combinations, say each level of potash with each level of nitrogen, has great advantages over empirical experiments. The following treatments might be employed where three levels each of potash and nitrogen are to be tested, and would, of course, be arranged at random in each block of a Randomised Block experiment:—

0N.0K	1N.0K	2N.0K
0N.1K	1N.1K	2N.1K
0N.2K	1N.2K	2N.2K

Set out as above, they are clearly a further example of local control. We have, within each block, sets of 3 plots treated with 0, 1 and 2 levels of nitrogen and with 0, 1 and 2 levels of potash. The balanced arrangement allows the calculation and comparison of variances appropriate to nitrogen, potash, and the interaction between nitrogen and potash as well as the usual variances due to blocks, treatments and error. The standard errors and significant differences for means of single plots and of sets of 3 plots are both of value in examination of average yield differences. Examples of the development of experiments of this kind have been given by Eden & Fisher (6).

Two intensities of each of three manures in all combinations might well be tested in this way also; but the arrangement of three intensities of three manures in all combinations as above would necessitate 27 plots per block and, even with 3 replicates, would require a total of 84 plots in the experiment—far too many for ordinary field work. It is to be stressed, too, that as larger numbers of treatments are included, the blocks may become so large that the variance due to soil differences within blocks increases compared with the variance between blocks, and the error variance, in consequence, becomes proportionately great. This difficulty can largely be overcome by use of one of two general methods of "confounding," the simpler types of which have been clearly expounded by Yates (23) who also indicates the modifications in analysis necessitated by their adoption.

The first of these is a simple reduction in the number of plots per block; one or more levels of the third fertiliser element (say phosphate) are used as basal dressings over whole blocks and its effects are thus entangled or confounded with variations due to fertility differences between blocks. If the number of blocks be sufficiently large, random replication of the chosen levels of this third fertiliser can be arranged and valid statistical treatment for phosphate effects and interactions are possible, as well as those for potash and nitrogen. In this case the phosphate effects will not be determined with the same accuracy as those for potash or nitrogen. If, on the other hand, the potash-nitrogen plots be split into sub-plots in which the phosphate dressings are varied, the effects and interactions of the latter will be determined with the greater accuracy. The split plot device has been widely employed at Rothamsted Experiment Station and numerous examples will be found in the more recent annual reports of this institution.

A second method of confounding, which greatly increases the accuracy of complex experiments and thereby enables reduction in the number of replications, consists in the entangling, not of treatments, but of treatment interactions with block differences. Yates gives the following example in which 4 Randomised Blocks containing all 8 combinations of two levels each of nitrogen, phosphate and potash are split each into two sub-blocks such that in Block 1 the second order interaction N x P x K is confounded, and, in Blocks 2, 3 and 4 respectively the first order interactions N x P, N x K and P x K are confounded.

Block 1.		*Block* 2.		*Block* 3.		*Block* 4.	
a.	*b.*	*a.*	*b.*	*a.*	*b.*	*a.*	*b.*
N	O	N	O	N	O	P	O
P	NP	P	K	K	P	K	N
K	NK	NK	NP	NP	NK	NP	PK
NPK	PK	PK	NPK	PK	NPK	NK	NPK

One quarter of the information on each of the interaction degrees of freedom is thus sacrificed, but the accuracy of the comparisons not confounded can be considerably increased by elimination of soil heterogeneity between sub-blocks, and the interactions may themselves even be determined with greater accuracy than in a straightforward experiment. Block treatments and plot arrangement in the sub-blocks are, of course, to be selected at random.

It is to be emphasised in connection with all complex experiments that they are more efficient than a series of isolated small experiments and that they afford a wider inductive basis for any conclusions drawn from them, since these conclusions are based on a wider background of experience than can be afforded by the simple experiment. Maskell has explained this somewhat as follows. Suppose, for example, there are 64 plots of land available for a manurial experiment involving 4 levels each of potash and nitrogen. Combining every level of

the one fertiliser with every level of the other in a straightforward complex experiment, we can arrange the 16 treatments in 4 Randomised Blocks. We could, on the other hand, compare the 4 levels of nitrogen at one constant level of potash in one experiment and the 4 levels of potash at one level of nitrogen in another, and in each of these simple experiments 8 replications would be possible. In the latter case, the effects of nitrogen and potash are determined by comparing the means of 8 plots, whilst in the complex experiment the general effects of nitrogen (independent of potash) and of potash (independent of nitrogen) are determined on means of 16 plots, i.e., with twice the accuracy of the two separate experiments. Moreover, although in the complex experiment the effect of potash at one particular level of nitrogen is determined with only half the accuracy (mean of 4 plots instead of 8) attained in the simple experiment, we obtain also comparable information as to the effect of potash at the other 3 levels of nitrogen. This, too, is to understate the case because greater elimination of soil heterogeneity can be arranged in the complex experiment than is possible in the two simple experiments, and the complex experiment provides information upon any differential responses which may exist among the different treatments.

The practicability of combining different types of questions in complex field experiments will be evident. Thus the comparison, say, of organic and inorganic sources of a fertiliser element may be combined with quantitative comparison of different rates of application; or a variety trial may be combined with a manurial experiment. The following extract from Hoblyn's paper is illuminating in this regard: "In an apple manurial trial, the answer may be a straightforward one, e.g., potash or nitrogen; but it is much more likely to be a combination of nitrogen and potash. Further, the answer may be different if the rootstock is varied, and yet again the correct result may only be achieved if the nitrogen and potash are put on at the right time of year: here is an experiment involving four factors, rootstock, potash, nitrogen and time of application, and it is quite possible or even probable that the truth may only lie in the interaction of all these factors . . . If two varieties A and B are being compared on two stocks I. and II., there are four different combinations of variety and stock, A.I., A.II., B.I., B.II.; and the variance between these four is split up into that part due to a difference between A and B, that due to the difference between I. and II., and that part which is caused by the interaction of A and B with I. and II. And this interaction, if, as so often happens in horticulture, A.I. is greater than A.II., but B.II. is greater than B.I., is the most important part of the experiment."

DIVERSE IMPORTANT APPLICATIONS.

Particular emphasis needs to be placed on the fact that the value of the above methods is by no means confined to field experiments. They have equally as valuable, or even more valuable application over a wide range of various types

of experimental work, particularly since Eden & Yates' (7) demonstration of the validity of Fisher's "t" and "z" tests for non-normal (skew) data. The application of the Analysis of Variance to sampling technique (2) is of general importance. The literature involving Randomised Block and Latin Square layouts in experiments other than field trials is becoming increasingly voluminous, but the following papers may be instanced as examples of their application to such widely diverse subjects as pot experiments (21), cereal chemistry (13), chemical physiology (5), entomology (3, 15), plant pathology (4), fruit storage experiments (1) and veterinary dietetics (25). It is to be emphasised, too, that each new avenue of application may call for employment of modified technique; however, the underlying general basis remains unaltered.

No pretence to originality is made for the present article. It was thought that a statement in general terms, by giving a skeletal comprehension of the possibilities opened up by modern methods, might aid in their more general appreciation. The writer is much indebted to Miss F. E. Allan for perusal and criticism of the manuscript and at other times for her kindly help on several questions.

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Some Aspects of Climate and Insect Ecology

by

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Considerable attention has been focussed during recent years on the influence of particular elements of climate and weather on the distribution, seasonal occurrence and fluctuations in the abundance of insects. Meteorological data for official recording stations are widely used for this purpose, particularly those relating to precipitation, temperature and humidity.

The methods employed in recording meteorological data were devised primarily with the object of obtaining precise knowledge about climate and weather. Owing to the varied situations inhabited by insects, the data are frequently inadequate for the purpose of expressing the changes which occur in their physical environment in these situations. In some instances, investigators take records of such factors as temperature and humidity in the micro-environment of the species they are studying. This affords valuable information relating to particular habitats, but the number of such records is necessarily relatively small. Considering the wealth of meteorological data which is available, and the importance of climate and weather in relation to insect life, it is desirable that more con-

sideration should be given to the analysis of the data with a view to establishing correlations between weather factors and the biological responses of insects; the methods of analysis will vary according to the requirements of particular investigations. It may be assumed that the micro-climate in a local situation will react to weather changes in the area; there will be a lag-period which will vary according to the degree of change and the type of local situation.

The desire for a better understanding of the influence of climate and weather on insects has resulted in a marked increase in experimental work dealing with their physiological responses to the physical factors of the environment. Precise information about insect physiology is essential for this purpose. This branch of entomology has been sadly neglected, and our meagre knowledge of the subject contrasts strongly with the advances which have been made in systematic work, morphology and general biology.

The climatic factors which influence the physical environment of insects may be classified as heat, moisture, light, air movements and barometric pressure. Considerable information relating to certain of these occurs in the literature, particularly with reference to the influence of temperature and humidity. In 1931, Mr. P. B. Uvarov compiled and reviewed this information in a paper published in the Transactions of the Royal Entomological Society of London. This valuable contribution has done much to stimulate research in this branch of entomology.

Temperature restricts or limits the geographical range of distribution of insects northwards and southwards in the Northern and Southern Hemispheres, respectively. The range of preferred temperature varies with the species, certain of them favouring warmer areas, and others colder lands. Temperature also restricts or limits the activities of insects to particular periods of the year owing to low temperatures in the cold season; certain species survive the cold months by hibernating in the egg, larval, pupal or adult stages.

Moisture restricts or limits the geographical range of distribution of insects into the dry areas of the world situated in the trade wind belts. It also restricts or limits their activities to particular periods of the year in regions having alternately a wet and dry season. Certain species survive the dry months by aestivating in various stages of development. Species differ with respect to their moisture requirements; those best suited to an arid environment appear to have a low water requirement or to resist the loss of body water.

Climatic factors therefore exert a dominating influence on the distribution of insects and fluctuations in their abundance. Studies of their physiology will enable us to understand how this is brought about. Apart from the consideration of geographical barriers, each species tends to extend into the regions suitable for its particular physiological requirements. Seasonal changes in these

regions determine the periods best suited for its activities; fluctuations in the weather influence temporarily its abundance by favouring or depressing its increase in numbers. The endemic area of a species may be considered as the area in which it has survived the range of variability of weather changes. Its range of distribution will extend beyond this area in favourable years.

Climatic factors influence the distribution of soil types and vegetation with which insect life is closely associated. These factors, together with biotic competition, all play an important part in determining the kinds of species which compose the insect fauna of an area and their fluctuations in numbers. In Australia, moisture plays a dominating role in the distribution and seasonal occurrence of insects. This is especially due to the well defined zones of winter and summer rainfall, and the wide range in the amount of precipitation and its reliability over the Continent.

The chief climatic elements which determine the moisture available for insects are rainfall and atmospheric humidity. Many insects inhabit the soil in their immature stages or throughout life. The degree of moisture present in the soil during any defined period is determined primarily by precipitation. Soil type and vegetation are important additional considerations. The efficiency of precipitation in maintaining adequate moisture in the soil depends upon the amount of rain and its distribution (number of rain days) together with soil type, vegetation and loss due to evaporation.

Various formulae have been devised by different investigators with a view to assessing the efficiency of precipitation in this respect, by taking into account the influence of temperature or of atmospheric saturation deficit on evaporation, or by direct reference to evaporimeter readings.

Where records for precipitation (P) and evaporation (E) are available, it is evident that the ratio P/E, month by month, affords a valuable index to the intensity of wetness or dryness in an area. The character of the evaporating surfaces in nature, namely the soil and its vegetation covering, offers considerable difficulty when evaporimeter records are applied to moisture conditions in the field, so that only an approximation to the actual evaporation can be expected. With these limitations, however, the index is a useful one for use in ecological studies. Unfortunately, there are relatively few stations for which records of evaporation are available.

The "Index of Aridity" proposed by de Martonne in 1926, in which precipitation (P) expressed in millimetres is related to temperature (T) in degrees centigrade $\left(\frac{P}{T + 10}\right)$ has been applied to the continent of Australia.

A simpler and apparently more useful ratio was proposed by A. Meyer in 1926. This ratio is obtained by dividing annual precipitation (P) expressed in

inches or centimetres, by the atmospheric water vapour saturation deficit (s.d.) also expressed in inches or centimetres. This ratio has been applied by Prescott in dealing with the distribution of native vegetation and soil types in Australia.

Annual values for these climatic elements are inadequate for ecological investigations, especially in Australia owing to the seasonal character of the rainfall. On the other hand, monthly values would appear to be helpful in studies relating to the seasonal occurrence and distribution of insects.

Monthly values for the de Martonne ratio have been applied to Australia by J. Andrews and W. H. Maze. The writer has used monthly values for the Meyer ratio, with the object of defining particular moisture areas in Australia; for this purpose, atmospheric saturation deficit was expressed in terms of evaporation by reference to evaporimeter records at the capital cities.

When the calculated monthly values for P/s.d. for each of the capital cities of Australia are plotted against the recorded monthly values for P/E, a linear relationship is observed; the formula for the line is $P/E = m \frac{P}{sd}$, where m is the value of the slope of the line. The value for m varies for the different stations, due to local variations in additional factors affecting evaporation, such as wind. It follows from the foregoing remarks, that a linear relationship is obtained for these stations when calculated monthly values for atmospheric saturation deficit are plotted against values for recorded evaporation.

With the aid of these basal principles, the writer defined the approximate areas in Australia, month by month, in which the calculated values for P/E are 0.5 or over, and those in which the values for this ratio are 1 or over. In this way, a general picture is obtained of the intensity of dryness or wetness over the Continent, month by month. By superimposing the twelve monthly areas, moisture zones may be defined for the year, showing the number of months in which selected values for P/E are maintained. The duration of the periods having particular values for P/E is important when considering the ratio as an index of aridity.

The moisture zones as defined above exhibit a close correlation with the distribution of native vegetation shown on Prescott's Vegetation Map of Australia (1931).

It is considered that monthly values for the Meyer Ratio P/s.d. will be helpful in studies relating to the seasonal occurrence and distribution of insects, where moisture is the limiting factor. Where suitable evaporation records are available, the ratio may be converted into values for P/E.

TECHNICAL NOTES

THE PRESERVATION AND STORAGE OF FRUIT.

The maintenance and extension of the fruit industry in Australia depends largely on the preservation of the fruit, by cool storage, from the time it is removed from the tree until it is placed on the market. Research work on cool storage problems was initiated by the various interested countries some years ago, and much valuable information has been obtained. The following brief notes refer to the work being carried out jointly by the Council for Scientific and Industrial Research and the Victorian Department of Agriculture at the laboratories and experimental chambers of the Department at the cool stores, Victoria Dock, Melbourne.

Fruit in cool store is affected, and its effective storage life is limited by disorders, many of which do not occur in fruit stored at normal temperatures. The research work being conduced at present is chiefly directed to the study of the fundamental nature of these disorders.

Previous experiments disclosed that in each particular kind of fruit the characteristic disorders appear in *regular sequence* after a certain period in cool store. This suggested that the disorders were normal changes associated with the senescence of fruit held at low temperatures. Efforts were then directed towards ascertaining the life histories of fruits in cool store with the object of determining, if possible, when any particular fruit reached its period of senescence. This was accomplished by collecting and measuring the daily output of CO_2 from individual fruits held at constant low temperature. To-day, apparatus for determining the rate of respiration of 120 individual fruits is available.

Plotting the results, it is found with all fruits that the rate of respiration increases to a point termed the climacteric, then falls—with some fruits rapidly, others slowly. With Williams pears the fall after the climacteric is very rapid, and respiration soon ceases entirely. This marks the death of the pear. It is on this downward drift of the curve, i.e., the senescent period, that the pear disorders make themselves manifest. Mealiness, core-collapse and finally scald appear in sequence, scald appearing just prior to the death of the pear. Pears removed from cool store before, but not after the climacteric is passed, can be ripened perfectly if removed to temperatures approximating the normal ripening temperatures for the varieties concerned. For instance, summer ripening pears, such as Williams, require a ripening temperature approximating 65 deg. F., while later autumn ripening pears, like Winter Nelis, can be ripened at a temperature as low as 50 deg. F.

Removed to a ripening temperature after the climacteric is passed, the pears will not ripen normally but rapidly develop the above-mentioned disorders.

The date of reaching the climacteric in cool store does not vary appreciably from season to season, nor do the growing conditions appear to have any significant effect. The time of picking—when the pear is fully developed but still hard and green—also does not vary appreciably from year to year, and in consequence the storage life for each variety, that is, from its arrival in store immediately after picking to a time just prior to the climacteric, is a "fixed" characteristic of each variety. For instance, at the best storage temperature, 30 to 32 deg. F., the Williams variety has a storage life of 12 weeks, while the Winter Nelis has a storage life of six months.

The behaviour of plums in cool storage is remarkably similar to pears. They also require picking when green but fully developed, and require storing at a temperature of 30 to 32 deg. F. They must be removed before the climacteric is passed, otherwise mealiness and internal browning (particularly around the stone) will develop. Plums ripen at temperatures as low as 50 deg. F., but compared with pears their storage life is very short. Indeed with most varieties the storage life when picked in a green condition and immediately stored does not exceed seven to eight weeks, and hence the export of plums overseas involves considerable risk.

The storage life of peaches is even shorter than that of plums, and with most varieties is limited to five weeks when stored at 32 deg. F.

Apples and oranges behave in cool store quite differently from pears and plums. They cannot be picked in a green immature condition, for although fruits so picked store well, on removal from store they cannot be ripened with normal development of flavour. Equally important however is the fact that they cannot be picked too mature, as their subsequent storage life is thereby considerably reduced. Apples require picking when the ground colour is just turning from green to yellow, while oranges should be picked as soon as they are possessed of fair eating quality. Both apples and oranges are picked closer to their climacteric than are pears, and they differ from pears in that they can be stored for a period appreciably beyond the climacteric. With these fruits the respiration curve does not fall sharply to zero after the climacteric is reached as is the case with pears, but the fall is slow and after a while the curve rises again. With the occurrence of this latter rise we find that there is a complete loss of flavour in both the apple and the orange. Shortly after this, the orange in particular appears to lose all natural resistance to mould attack, for it is usual to expect general mould attack at this stage in the life of the orange. Indeed we would say that general mould attack is a normal occurrence in senescent oranges.

With Washington Navel oranges, we find the optimum picking time to be about mid-June. Navels picked at this time have a storage life (limited by loss of flavour) of 12 weeks. If picked later than mid-June, the storage life is reduced by the length of time the fruit is allowed to stay on the trees after this date. Navels stored beyond the maximum period of 12 weeks lose all their flavour and shortly afterwards are invaded by mould.

With all fruits examined, the study of the respiration curve has proved practically essential to a proper understanding of cool storage behaviour, and offers the logical basis upon which more detailed knowledge may be built.

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SOIL COLOR CLASSES

The definition of color is an essential feature in the classification of soils in a soil survey. Considerable attention has been paid to it in America in an endeavour to secure uniformity of color description by field men in all parts of the country, and a color scale was prepared by a committee of the American Soil Survey Association about 1927. The scale was decided on from measurements obtained by comparing soils of various colors with the color produced by spinning Maxwell Color discs in different combinations. The colors employed were black, white, yellow and red, the discs being printed by the Munsell Color Co., Baltimore, U.S.A., and standardised accurately by the U.S. Bureau of Standards. They are described as follows: Black-Neutral 1/-; White-Neutral 9/-; Red 4/9; Yellow 8/8.

Now that soil survey work in Australia is claiming the attention of an increasing body of workers, the preparation of a color scale for Australian soils is desirable and the present note is an indication of progress.

The black, white, yellow and red Munsell discs were used and spun in combination on a turntable fitted to an electric fan motor running at 3,000 r.p.m. The speed is immaterial provided flickering is overcome. For matching purposes the dried ground soil was stuck on to small circular pieces of bristol board with a central hole, using a moderately thick colorless duco solution. The soil card was slipped on to the centre spindle of the turntable and held down by a lock nut so that it whirled with the other color discs, allowing a good comparison to be made. Some hundreds of measurements have been made on the "color wheel" in an attempt to define the range in percentage composition of the soil color classes in terms of the four colors.

Probably between 22 and 25 colors will be sufficient to give a good scale for field working. A selection of these is given in Table 1 together with average measurements on the color wheel showing the proportion of the black, white, yellow and red colors employed for closest matching. For comparison, the Ridgway color standards to which the soil colors most closely correspond are given in column 6:—

TABLE 1.

Soil Color	Percentage Proportion of				Nearest Ridgway Color Standard
	Black	White	Yellow	Red	
Red	50	0	9.5	40.5	Mahogany red
Dark reddish brown	67	0	9	24	Auburn
Reddish brown	54	0	11	35	Kaiser brown
Chocolate	79	0	5.5	15.5	Mars brown to Prouts brown
Dark brown	71	1	9	19	Natal brown to Army brown
Brown	52.5	4	15	28.5	Cinnamon to Snuff brown
Light brown	32.5	8	22.5	37	Fawn
Light greyish brown	39.5	17	20	23.5	Light drab
Grey	45	24	16	15	Drab grey
Dark grey	68.5	10.5	11	10	Drab—
Black	86	7	3	4	Chaetura drab
Yellow	27.5	4	34	34.5	Yellow ochre

Additional colors defined are dark red, light reddish brown, light yellowish brown, yellowish brown, light grey, greyish brown, greyish yellow, white, very dark brown, dark greyish brown, greyish black. Drab and fawn may be useful alternatives.

A study of the available data emphasises the following features:—

1. The high percentage of black and the dominating effect of red over black as a coloring factor in red, reddish brown and brown soils.
2. The absence of white in red to reddish brown soils. It is always low in brown soils.
3. In grey to black soils, white is always higher than yellow or red and generally is equal to the sum of these two.
4. Yellow only exceeds red in the strongly yellow soils.
5. As a soil color, white is difficult to tie down to a small range. It would appear to run from a creamy white to a pale smoke grey (Ridgway) which may contain 30 per cent. black in a color wheel measurement. Considerable trouble has been experienced with yellowish brown and greyish yellow colors both of which are useful for subsoil descriptions.
6. Black is regarded as including any soil color containing more than 85 per cent. black with a dominance of white over yellow and red in its analysis.

The range of proportional figures obtained for soil color groups by spinning combinations of black, white, yellow and red color discs may be treated mathematically to determine the significance of the grouping. If the color classes are distinct according to this test it should be possible to sub-divide a tetrahedron, taking the four apices as 100 per cent. black, white, yellow and red, into compartments representing the classes. Tentatively this seems feasible and the work is to be continued with this object in view.

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LUCERNE SEED "INOCULATION" IN QUEENSLAND

The inoculation of legumes has proved highly successful in many countries, and has now become a routine practice. In Australia the problem has not been widely investigated, although in Western Australia the Rothamsted technique has been employed with success. A varied leguminous herb-flora in most of the agricultural areas of Australia has indicated that there may be little need for inoculation, and this view is supported by the fact that most crop and pasture legumes have been observed to develop nodules freely. This in itself is not proof, however, that seed inoculation may not prove advantageous, particularly where natural legumes of the requisite cross-inoculation group are lacking, or the root-nodule organism has become attenuated, due to a temporary lack of host plants.

The following results were obtained from a preliminary investigation of the inoculation problem, carried out at the instigation of the Queensland Faculty of Agriculture.

Treatment.—Lucerne seed inoculated and seed not inoculated, both with and without superphosphate at 2 cwt. per acre.

Field Conditions.—Soil, a typical alluvial loam of the Brisbane Valley dairy-farming area (pH — KCL extract 4.8-5.0,—water extract 5.7-5.8). Marked response of lucerne to phosphatic fertilisers: marked response of non-leguminous crops to nitrogen. Lucerne had been grown until ten years previously, after which the land had been in natural pasture containing a few Medicago plants.

System of Replication.—Compound paired strips in triplicate; each strip, $\frac{1}{8}$ acre.

Summarised Yields (2nd Cutting).—These were as follow:

	Lbs. per acre (hay)		Per cent. of Mean	
	Fertilised	Unfertilised	Fertilised	Unfertilised
Inoculated	2207	1525	137.93	103.81
Not inoculated	1296	1029	88.2	70.05

Standard error (of mean)—12.01%.

Highly significant differences in yield were obtained, due to both fertiliser and inoculation.

Nodule Counts.—Nodule counts were made 10½ weeks after planting, the individual plants being chosen at random. Results:

	No. of Plants	No. of Nodules	Av. per Plant
Inoculated	24	397	16.5
Not inoculated	34	69	2.0

An excellent stand of lucerne was obtained with inoculated seed, despite late planting, weed competition, downy mildew attack and dry weather in early spring, conditions not abnormal in Queensland for lucene. Only a small percentage of uninoculated plants survived and although these plants bore nodules in considerable numbers six months after planting, it appeared that the stand would remain permanently inferior to the stand that had been inoculated.

Application.—Most of the lucerne in Queensland is grown upon alluvial soil, black clays, and red-brown volcanic soils. On the alluvial soils of the subcoastal areas, plants of the lucerne cross-inoculation group seldom seem to become thickly distributed. Here, seed inoculation practice appears to offer material scope. On the alluvial soils of the south western districts, however, where irrigation is available, there is frequently a burr clover "mat" and the practice may not offer the same advantages. The fertile calcareous black clays provide excellent conditions for micro-organic activity and usually possess a high nitrogen level following cultivation. Legumes of the genera Medicago and Melilotus are well distributed and often become insidious weeds.

Though fertile in their natural state, the red-brown volcanic soils become depleted by frequent cultivation. Upon the Atherton Tablelands, legumes of the Medicago and Melilotus group are not very common, and seed-inoculation may prove beneficial. Where lucerne is employed in pasture mixtures, it is desirable that seed inoculation should be given due consideration.

Investigations in other countries have proved that Rhizobial strains exist which vary considerably in their ability to fix and supply nitrogen. The use of a more efficient strain for inoculation purposes, therefore, may further widen the application of the practice, not only for lucerne but for various other legumes as well.

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THE STAG-HORN FERN BEETLE, *HALTICORCUS PLATYCERII* LEA.

During the past few years in the Sydney district, stag-horn ferns have been considerably damaged by the stag-horn fern beetle, *Halticorcus platycerii* Lea, particularly during the late summer and autumn.

Froggatt (1) stated: "The beetles lay their eggs upon the base of the fronds and the slender reddish-yellow larvae (with blackish head and legs) crawl over the surface of the stout fronds and gnaw regular oval furrows in the tissue."

During 1934, the life history of this beetle was studied by the writer, and it was found that the adult beetles were responsible for the oval holes in the fronds, and not the larvae as formerly believed, and that the eggs were embedded in cavities in the fronds, the insect throughout its larval life being a true leaf-miner.

The adult beetle, which was described by Lea (2), belongs to the family Chrysomelidae, Sub-family Halticinae. It is more or less hemispherical in outline, the average length being 3.2 mm. The dorsal surface is black in color, with iridescent reflections, the elytra being marked with four orange spots, the hind pair of spots being larger and more irregular in outline. The under surface of the abdomen is orange in color. The hind legs are adapted for jumping, and when disturbed the beetles both jump and fly readily. Superficially the beetles resemble the beneficial steely-blue ladybird beetles belonging to the genus *Orcus*, and for this reason are frequently left undisturbed when damage is occurring.

A single adult beetle in one day may eat out several dozen irregular holes, usually in the dorsal surface of the frond. A considerable quantity of liquid exudes from the wound and this later dries, while the cells on the edge wither and die, leaving an even edged oval cavity.

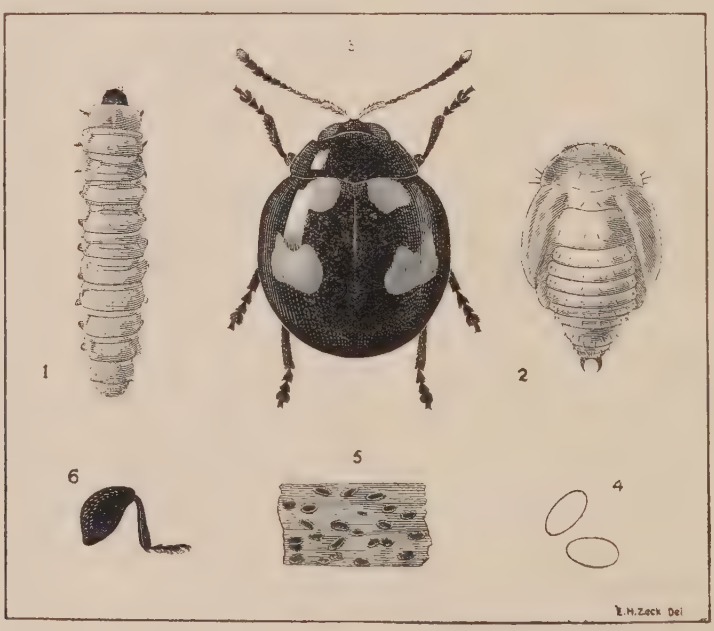
Prior to egg deposition, the female eats out a small elongate cavity in the frond, which is slightly longer and wider than the egg. The egg is laid in this cavity and is covered with a secretion which on drying seals up the cavity. This secretion is somewhat transparent, and it is possible to see part of the egg through it. Sometimes a little excrement is deposited over the oviposition site.

The egg, which is pink in colour, is elongate cylindrical with rounded ends. It averages 0.7 mm. in length and 0.35 mm. in width. The chorion is fairly soft and the surface is smooth and glistening. The eggs are laid singly and are usually embedded in the dorsal surface of the frond.

The larva on hatching forces its way through the end of the egg and commences to mine in the frond tissues, it being necessary for the larva to eat out a cavity in the tissues before it can completely emerge from the egg.

In general outline the newly hatched larva which averages 0.9 mm. in length, is very similar to the mature larva, but the body is semitranslucent. The head is black and the region of the alimentary tract is pink.

For a few days the larva in feeding eats out a tunnel within the frond, which is little wider than its own breadth. Where numbers of larvae are present—and as many as 40 have been counted in a single frond—their tunnels soon meet and they then commence to feed side by side, with the result that the greater part of the internal tissues may be devoured. The outlines of the mining larvae can be clearly seen by holding the frond up to the light. The injured tissues become infected with rot organisms, and the fronds turn brown and fall prematurely.



THE STAG-HORN FERN BEETLE
Halticorcus platycerii Lea.

1. *Mature larva* (x5). 2. *Pupa* (x10). 3. *Adult* (x10). 4. Eggs (x10). 5. *Portion of frond showing typical damage caused by adults feeding (slightly reduced).* 6. *Lateral view of hind leg of adult* (x10).

When the larva is mature it measures 8 mm. in length, the body being orange in color, the head and legs black. The abdominal segments bear lateral protuberances on which the spiracles are situated.

On reaching maturity the larva eats its way out of the frond, crawls down to the base, and either eats out a rounded hole in the broad sheath-like sterile

fronds, or works its way in under the loose edges of the latter. The larva then eats into the fleshy underlayers and there constructs an oval cell in which it pupates.

The pupa is at first orange in color, but shortly before emergence the black eyes of the adult become evident.

The adults live for long periods, several which were collected in the field early in March, 1934, surviving until the middle of the following October.

Females under observation in the laboratory laid small numbers of eggs daily for a period of two months, and one female which emerged in March, 1934, was observed ovipositing in the following August.

In the autumn of 1934 the incubation period varied from 9 to 12 days; the larval feeding period varied from 28 to 31 days, and the pupal period averaged 17 days, the total life cycle being approximately 10 weeks. A number of overlapping generations occur throughout the year.

N. S. Noble.

Department of Agriculture,
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(1) Froggat, W. W. Entomological Notes. Agric. Gaz. N.S.W., 28: 891-895, 1917.
(2) Lea, A. M. Notes on some miscellaneous *Coleoptera* with descriptions of new species. Part III: Trans. and Proc. Roy. Soc. South Australia, 41: 121-322, 1917.

THE GRASS-LEGUME ASSOCIATION IN PASTURES.

Agronomists in general have to deal with individual farm crops, and it is natural that in agriculture we should tend to think in terms of single botanical units. Even in pasture work there is a tendency to be attracted by the importance of a single species such as lucerne, subterranean clover, perennial rye-grass or one or other of their strains, and to forget that under conditions of intensive grazing the combination of grass and legume is probably indispensable for maximum productivity, as well as for satisfactory animal nutrition.

Recent work in South Australia indicates that on soils of low or high total nitrogen content, the seeding of a single grass or a single legume such as subterranean clover or lucerne, for grazing purposes, does not result in so high or sustained a production level as a blended mixture of grass and legume complements.

Thus, on the fertile Murray swamps, perennial rye-grass yielded 47.73 cwt. per acre over twelve months following seeding when sown alone, and 61.61 cwt. per acre over the same period when sown with white clover, red clover and cocksfoot. In the course of trials at the Waite Institute and various country centres, it has been a matter for common observation that seeded grasses have been healthier and more vigorous when sown with legumes than when sown alone. Conversely, the establishment of pure subterranean clover and pure

lucerne for grazing purposes usually leads to invasion by weeds and inferior grasses in the third or fourth year of the pasture, due to a rising level of available soil nitrogen, much of which is gained by the return of herbage-nitrogen in animal excreta.

Nitrogen fixation in subterranean clover probably varies within wide limits but its order, in experiments conducted at the Waite Institute, has been found to approximate 43 lb. N per ton of dry clover herbage. Of this, however, only 5 lb. or thereabouts are present in the root system and root exudate. Allowing 60 per cent. recovery from the grazed herbage, the net soil gain would be in the neighbourhood of 27 lb. N per acre. On this basis, two successive crops of 2 tons each, if grazed, would enrich the soil by approximately 108 lb. N, equivalent to 5¼ cwt. sulphate of ammonia per acre.

The fate of nitrogen gained by the soil as a result of legume production is somewhat obscure, but it is apparent that the continued accumulation of legume nitrogen must tend to encourage the development of grasses and other non-legumes. Calculations based on the known variations of nitrogen content in grass, and on varying degrees of recovery under grazing, indicate that provided there is no serious loss of available soil nitrogen, the general trend in legume-rich pastures will be towards ultimate domination by non-legumes, with the retention of the legume complement in a smaller but still necessary proportion.

At the present time there is much evidence that the grass:clover ratio in pastures fluctuates widely, and it appears that these fluctuations are largely influenced by the relative supplies of available nitrogen and phosphorus in the soil. Stabilization, within limits, of the grass:clover ratio is desirable and can probably be obtained by management, provided we can understand more fully the symbiotic relationships of grasses and legumes in association.

The recent work of Virtanen in Finland and of Thornton and Nicol at Rothamsted has stimulated interest in the phenomenon of associated growth. Nicol (Biol. Reviews IX, 1934, p. 383), in reviewing the question of nitrogen nutrition in relation to crop plants, concludes that the existence of a transfer of nitrogen from growing legumes to associate non-legumes can be taken as well established. There is evidence that transference may occur during nodule formation, as early as 12 weeks from seeding. The mode of transference is still obscure, but Virtanen found that 77.4 per cent. of the presumably excreted nitrogen was in the form of amino-N.

The question is not a simple one and factors of the root environment such as pH, the concentration of various other ions, the ratio of soil gases and the presence of de-aminizing and denitrifying bacteria may determine whether transference occurs, and its extent if present. Furthermore, the particular strain of root-nodule organism and the species or strain of both host-legume and associated non-legume may be important. The problem is being investigated at the Waite Institute, and much work appears to be in progress overseas.

In the meanwhile, the question of associated growth in pastures is of such biological significance and practical importance that the concept of the grass-legume association as a basic unit of grassland is worthy of more general acceptance.

There is much evidence in South Australia of the advantages to be secured by the use of suitable rye-grasses and *Phalaris* in conjunction with subterranean clover, while the successful development of lucerne-*Phalaris tuberosa* mixtures under grazing conditions opens up interesting possibilities with these two species.

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IMPROVEMENT OF WHEAT QUALITY IN RELATION TO THE F.A.Q. SYSTEM OF GRADING.

A consideration of the desirable standard of quality for Australian wheats invariably leads one to a study of the requirements of existing and possible future markets, and to the manner in which the fulfilment of these may be affected by a departure from the present standard of quality under the F.A.Q. system of grading.

Wheat, so often considered a single commodity, is used for varied purposes, each of which needs different characteristics in the grain. With the exception of sales to the Orient, the requirements of which are not yet known, Australian wheat is exported principally for bread baking and cake and pastry making. These industries use wheat of opposite types.

The cake and pastry industry, for which Australian grain is well suited, requires a weak wheat. Improvement in this type of wheat, while desirable, is not urgent.

For bread baking, Australian wheat is blended, in Europe, with the strong wheats of Canada and U.S.A. It has a definite place in the blend because of its high return of flour, and its colour and lustre. There is a limit, however, to the amount that may be included. This limit is set by its comparative weakness which, when large quantities are used, reduces the average strength of the blend below that which is necessary for the production of good bread.

An improvement in bread baking quality would raise this limit, and allow greater quantities of Australian wheat to be included. Because the larger proportion of our wheat is exported for bread making purposes, the tendency rightly has been to improve this characteristic. The home market also favours improvement in this direction.

All the effects of such a change in quality may not be desirable. If the average strength of Australian wheat is improved, its usefulness for cake and

pastry manufacture must be adversely affected. Also, it must follow that greater variation in quality will occur between samples, thus the exported product will be less uniform and possibly less attractive to some buyers. Furthermore, unless those qualities for which Australian wheat is now in demand, namely, flour yield, colour and lustre, are maintained at a high standard, vigorous competition with the filler class of wheats from Argentina and U.S.A. will be encountered.

These disadvantages could be overcome by the adoption of a grading system other than the F.A.Q. standard. Systems based on quality grades appear to be impractical under existing conditions, mainly because of economic and administrative difficulties.

As climatic and soil conditions vary considerably within the wheat belt of Australia, some localities, more than others, are conducive to the production of wheat of greater strength. The most efficient system of production would be that in which each locality grew the type of wheat for which it was most fitted. The co-operation of plant breeders and State Departments of Agriculture could do much to attain this. It would then be logical to base a grading system upon locality and variety, including some of the features of the present system. Thus the necessity for quality determinations upon individual samples would be eliminated.

A survey of the wheat growing areas to determine the localities best adapted to the production of wheats of greater strength would assist considerably in this direction. Little information of this type has been published, and data from different States are not always comparable.

The introduction of a revised grading system is not an immediate necessity because, probably, it will be several years before the efforts of plant breeders to combine good baking quality with high yields will be reflected in wheat samples. Thus there would be ample time for the necessary information to be obtained and the organisation accomplished.

The tendency to improve baking quality appears to be world wide. This, coupled with the possible extension of production of hard wheats in Canada and Russia, may soon determine that premiums often paid for strong wheat will be conferred upon those of a weaker class. It would be wise, therefore, for Australia to remain in the position of being able to supply such wheats.

The adoption of a grading system based upon locality and variety would, by allowing millers to buy according to quality, enable the requirements of both markets to be met.

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The Australian Institute of Agricultural Science

SOUTH AUSTRALIAN BRANCH

The progress of the South Australian Branch has been particularly rapid and two well-attended meetings have now been held, in addition to the meetings of the Agricultural Sciences Club, Waite Institute. Of 46 persons in South Australia who were invited to become members of the Institute, 43 are now financial corporate members.

At the second meeting, held at Adelaide on 27th June, Professor A. E. V. Richardson outlined the progress of the Institute as a whole and pointed out that the future success of the Institute would depend largely on the healthy and vigorous development of the local branches. Business dealt with by the meeting concerned the view of the Branch regarding the authority of the Federal Executive to act for the Federal Council, the adoption of S.A. Local Branch regulations and the election of delegates to the Federal Council. The meeting gave it as its opinion that the Executive Committee should have power to act for the Council in the election of members under Article 5, Clause (a), Section A, until the appointment of the Council and for a period not exceeding one year. The regulations of the South Australian Branch, as drafted by a sub-committee, were adopted by the meeting. Dr. A. R. Callaghan and Mr. H. C. Trumble were appointed as delegates of the South Australian Branch to the Federal Council. The President (Prof. J. A. Prescott) announced that a Roll had been prepared in which all financial members of the State were invited to sign a declaration in which members agreed to be bound by the Constitution and Regulations of the Institute.

Professor Prescott then gave a short account of Land Utilization Surveys, based on the recent work carried out in Great Britain at the instigation of the London School of Economics, and the activities in this direction of the School of Geography of the University of Sydney. Committees of the Pacific Science Association and of the Institute of Pacific Relations also exist for such studies and the latter has inspired work in the Departments of Economics and Agriculture at Melbourne University. The Pacific Science Association expects to limit its studies to the fundamental bases of land utilization, such as climate, soils and native vegetation. Soil surveys, therefore, become a necessary basis for such work. Further investigation is needed regarding the reliability of seasonal rainfall and its efficiency as determined by evaporation factors. It should eventually become possible to map provinces suitable for specific types of exploitation, having regard to the size of unit necessary for the maintenance of living standards and the grouping of units in sufficiently large areas to provide communal services. In connection with Professor Prescott's address it is of interest to note ("Nature," 20th April, 1935, p. 614) that according to the Fourth Annual Report of the Survey in Britain, only 10 per cent. of the total area of Great Britain has still to be mapped.

TASMANIAN BRANCH

The first Committee meeting of the Branch was held in Launceston on May 17, and certain sections of the Constitution which had been left in the hands of the Committee by the general meeting of April 16 were finalised. Considerable discussion took place on Section 5, Clause 4 of the Federal Constitution, and it was finally agreed that for Branch membership the number of non-graduates should at no time exceed half the total graduate membership. Requisite nominations were received for, and enrolment forms forwarded to, the following non-graduates:—

Mr. F. E. Ward, H.D.A., Director of Agriculture.

Mr. W. M. Carne, F.L.S., Senior Research Officer, C.S.I.R., University of Tasmania.

The subscription to the local Branch was fixed at 2/6 per annum, with an additional levy of 2/6 should the need arise.

Owing to members being stationed at widely separated parts of the State, it was agreed that for the time being the holding of regular general meetings was out of the question. In regard to the annual general meeting, it was considered that the most likely time to get the majority together would be during either the Launceston or Hobart Show periods, and that the date be fixed at a special Committee meeting to be held in September. It was decided that Committee meetings be held quarterly, as soon as possible after the publication of the Institute's journal. Arrangements were made for an exchange of constitutions with New South Wales, Victorian and South Australian Branches.

The second quarterly Committee meeting was held on 28th July. Two questions on which the Branch was asked to express its opinion were: (1) "Can the Executive Committee act for the Federal Council in the election of members?" and (2) "Should Foundation Membership be available to non-graduates." The opinion was affirmative in both cases.

The medium for the transfer of funds was discussed and a recommendation was forwarded to the Executive Committee: "That that account of the Institute be placed with the Commonwealth Bank, for the following reasons:—

1. As a national institution established for such purposes, it should be supported;
2. The Commonwealth Bank has assisted agricultural research by the provision of finance;
3. A considerable monetary saving to the Institute could be made in the transferring of funds by using this Bank's system of 'Society Accounts' on which no exchange is paid."

Accounts were passed for payment.

FORMATION OF QUEENSLAND BRANCH

The foundation meeting of the Queensland Branch of the Institute was held on August 6th in the Entomology Department of the University of Queensland. Professor J. K. Murray occupied the chair. A tentative constitution for the local Branch prepared by a committee consisting of Messrs. R. Veitch, A. F. Bell, and R. E. Nixon-Smith was adopted after discussion and amendment. It was decided that membership in the local Branch should be restricted to corporate and student members of the A.I.A.S. The election of office-bearers for the ensuing year resulted as follows:—

President: Professor J. K. Murray, B.A., B.Sc. Agr.

Vice-President: Mr. R. Veitch, B.Sc. Agr., B.Sc. For., F.R.E.S.

Hon. Secretary-Treasurer: Mr. C. W. Winders, B.Sc. Agr.

Hon. Editor: Mr. H. K. Lewcock, M.Sc., B.Sc. Agr.

Council: The above, together with Messrs. A. F. Bell, M.Sc., A. F. Perkins, B.Sc. Agr., and R. E. Nixon-Smith, B.Sc. Agr.

The Branch placed on record its appreciation of the services of Dr. L. G. Miles during the period of its formation. The next meeting of the Branch, which is to be held on September 13th, will take the form of a symposium on "Pasture Improvement," and the final meeting for the year has been fixed provisionally for November 8th. The Branch at present has twenty-eight financial members, all graduates, and it is anticipated that this number will be considerably augmented before the end of the year.

Current Notes and News

NEW PROFESSOR OF AGRICULTURE, UNIVERSITY OF W.A.

Professor James Edward Nicholls, M.Sc., Ph.D., F.R.S.E., arrived at Perth in June to commence duties as Hackett Professor of Agriculture in the University of Western Australia. Dr. Nicholls, who is 32 years of age, was educated at Durham University

Professor J. E. NICHOLLS
M.Sc., Ph.D., F.R.S.E.

(Armstrong College) where he graduated B.Sc. and M.Sc., and at the University of Edinburgh where he gained the Ph.D. degree in 1927. In January, 1924, he entered the animal breeding research department (now the Institute of Animal Genetics) of Edinburgh University under Prof. F. A. E. Crew, and he was a member of the staff of the department until 1928. He also held a research fellowship of the Wool Industries Research Association in 1924-26 for the study of problems of fertility of sheep and wool growth. From 1928 to 1931, under a special grant from the Empire Marketing Board, he undertook a survey of conditions of wool production in the British Empire on behalf of the Association, and visited Australia, New Zealand, South Africa, Southern Rhodesia, Kenya, Palestine, and Canada. At the conclusion of this work he was appointed head of the biology department of the Wool Industries Research Association at Leeds, England, and held this position until his recent appointment to the Chair of Agriculture in W.A. He is a specialist in genetics, animal nutrition and wool research.

We extend to Professor Nicholls best wishes for success in his new sphere of work.

AGRICULTURAL SCIENCES CLUB, S.A.

Meetings of the Club were held at the Waite Institute in May and July. At the May meeting, short technical papers and exhibits were presented. An account of these is given hereunder:—

"The Twort D'Herelle Phenomenon," by Mr. D. B. Adam. The historical side of the study of bacteriophagy was sketched, with special reference to the work of D'Herelle. Reference was made to a bacteriophage which had appeared in cultures of the bean blight bacillus (*Phytomonas medicaginis* var. *phaseolicola*) at the Waite Institute. This principle was highly specific and did not attack other cultures. Potency increased with repeated sub-inoculation. It was not affected by 90 per cent. alcohol and no evidence of respiration could be demonstrated. Exhibits were presented which demonstrated its lytic action on broth cultures and agar plate colonies of the bacillus.

"The Concept of Degrees of Freedom," by Mr. E. A. Cornish. A three-dimensional model was employed to demonstrate the mathematical concept implied by the term "degrees of freedom." The exhibit illustrated the principles involved in dealing with samples of three. It was shown that in this case, if the sample is represented by a point in space, referred to a set of axes mutually at right angles and the sample values are expressed as rectilinear Cartesian co-ordinates, then after computation of the mean and standard deviation, the representative point must lie in a known plane relative to the axes, and on the circumference of a circle of known radius lying in that plane. These data supply two independent conditions with which to specify the position of the sample point relative to the axes, leaving only one degree of freedom in which the sample may show variation. It was pointed out that the proof might be generalized for samples of any size; it was difficult, however, to conduct before a non-mathematical audience an argument involving the exquisite abracadabra of n-dimensional geometry.

"The Life History of *Chortoicetes terminifera* Walker," by Mr. D. C. Swan. The life history of the Plague Grasshopper was described as it occurred in cage colonies at the Waite Institute. Eggs laid in the summer of 1934 were obtained near Murray Bridge and provided the necessary material. The conditions necessary to initiate development, and the mechanism of hatching were indicated.

"A Classification of Soil Colours," by Mr. J. K. Taylor. The importance of soil colour in field work and soil classification was stressed. The content of organic matter, iron oxide and moisture were said to influence soil colour; $CaCO_3$ (giving greys) and manganese may also have an effect, and the colour may appear different at different times of the day. Carded soils and small soil blocks were exhibited as standards. An American spinning disc with variable segments of red, yellow, black and white was also shown. Professor Prescott, in discussion, referred to the use of subtractive primaries + white, in the spinning disc. Other possibilities included the measurement of the wave-length of the reflected light.

"Yields of Mixed Pasture with Varying Nitrogen and Phosphorus Supply," by Mr. H. C. Trumble. It was pointed out that the yield of a single grass or single legume falls off due to derangement of the available soil nitrogen level. To maintain production in the absence of cultivation, grass-legume combinations appear essential. The application of nitrogenous fertilizers frequently lowers nitrogen recovery owing to legume depression. Three-dimensional models constructed from experimental data were employed to illustrate yields of grass and clover with varying N and P supply. These indicated, amongst

other things, that given adequate available nitrogen, the amount of phosphorus required to produce full response in grasses is relatively small.

At the meeting held on 25th July, Mr. J. A. La Nauze, Lecturer in Economics at the University of Adelaide, gave an interesting address on "Some probable consequences of present population trends." Mr. La Nauze produced figures to indicate that a long-range trend in the direction of decreased future populations has been occurring in most Western countries, including Great Britain in particular. This has probably been accentuated by the war and post-war depression. All authorities are agreed that contraception is a main factor, associated with a rising standard of living and of intelligence. It has been estimated that on present trends, the population of Great Britain will rise to 45,144,000 in 1936, then gradually fall to 32,712,000 in 1976. At the same time, the percentages of old and young people will rise and fall respectively. It was stated that the trends are unlikely to be altered much by decreased mortality or an increased number of marriages, whereas experience in Italy, Ireland and Spain has shown that neither religious nor political influence is likely to be effective. Some speculation was made as to the probable future effects of decreasing white populations. It was suggested that decreased aggregate production would be associated with increased quality of products, an increased production of delicacies and greater wealth and leisure per person. Possible repercussions on Australian primary production were also suggested. The address prompted an interesting and animated discussion, in which it was pointed out that past and present trends did not necessarily govern the future; for this, the failure of predictions made in earlier periods provides abundant evidence; and it is by no means certain that the present decreased fertility of the Western races will continue. The view was also expressed that the obvious shortcomings of the existing economic structure are responsible for much present-day uncertainty and that many of the difficulties of supply and demand which are now evident would tend to be remedied by the provision of a sounder and more rational system. Nevertheless, Mr. La Nauze brought forward an important thesis, which afforded much food for thought.

MELBOURNE UNIVERSITY AGRICULTURAL SOCIETY.

Mr. W. R. Jewell, M.Sc., Agricultural Research Chemist of the Department, gave a lecture to the M.U.Ag.S. on 10th May. His subject, "Our Daily Bread," dealt with the composition of flour and the general chemical actions involved in the production of bread. The baking quality of flour was shown to be dependent upon the amount and quality of the gluten and on the diastatic capacity. The various methods of measuring the baking quality which were described, included Brabender's method, the standard baking test and the Pelshenke test. It was explained that the variety and environment during the growing season affected the quality of the wheat. Hot, dry summers hastened maturity and tended to produce higher protein and quality. With regard to soil fertility, the higher the content of soil nitrates the better the baking quality. Reference was made to the bleaching of flours and the use of "improvers," and a number of sample loaves were exhibited to illustrate the various points.

On 24th May, Mr. G. L. Sutton, Director of Agriculture, W.A., addressed the Society on "The Economic Valuation of Australian Wheats for Commercial Purposes." He pointed out that from his experiences in Western Australia, the present F.A.Q. system of classification had proved unsuitable to both the exporter and to the farmer producing good quality grain. An alternative system based on the percentage of millable grain, using three standard types, viz., Soft White, Standard White, and Premier Strong

White, was suggested. A machine for determining the millable equivalent was demonstrated also.

The first joint meeting of the M.U.Ag.S. and the Victorian Branch of the A.I.A.S. was held on 14th June. Mr. Bartels, B. Agr. Sc., Senior Agrostologist of the Department, spoke on "Pastures and Farm Management in the Irrigation Districts of Victoria." It was pointed out that owing to the extension of the State Rivers and Water Supply Commission's schemes it had been found possible to support 3,400 families in the irrigation districts whereas prior to irrigation 180 families only were supported on the same area. The crops grown successfully under irrigation in Victoria included lucerne, sorghums, sugar beet, potatoes, maize and pastures. Mr. Bartels indicated that extensive tests were being carried out at the State Research Farm, Werribee, with regard to the watering, manuring, cutting and rotational grazing of irrigated pastures. The soil alkali problem was discussed also.

On 5th July, Dr. W. J. Young, Associate Professor in Bio-chemistry, delivered an address on "Some Recent Work on the Ripening of Fruit." Dr. Young traced the life of the fruit, indicating the changes which took place in the various constituents, from the pollination of the flower until ultimate death. The object of the scientist was to delay the onset of the climacteric—the highest point in the respiration curve—after which respiration processes declined rapidly, resulting in death of the fruit. Carbon dioxide may be used for this purpose, but great care had to be taken to maintain the correct concentration. The effect of ethylene in hastening the ripening of fruit was described, and the similarity of this effect to that shown by the volatile gases given off by ripening fruit was emphasised.

A most interesting illustrated address was delivered to the Society on August 2nd by Mr. O. H. Gepp, B. Agr. Sc., who described some of his experiences while on his recent visit overseas. Mr. Gepp was much impressed by the pasture work in New Zealand, the first country visited. The outstanding point of interest was the fact that a very large proportion of the Dominion dairy farmers were actually applying the latest methods of pasture management on their properties. Although pasture research in Great Britain had been very highly developed and excellent work had been conducted in establishing the relations between species and management, the British farmer had not been so receptive of the new ideas and the position of the general pastures there was not up to that of New Zealand. The speaker also dealt with the latest developments in drying grass hay and in cereal and fruit research in Great Britain.

Social News.—The annual "At Home" of the M.U.Ag.S. and the A.I.A.S. (Victorian Branch) was held at Tudor Court on 16th August. There was an attendance of 150 members and friends who were welcomed by the Presidents of the respective bodies, Dr. L. A. I. Maxwell and Professor S. M. Wadham. Among the guests were the Vice-Chancellor (Dr. R. E. Priestley) Mrs. and Miss Priestley, and the President of the Students' Representative Council (Mr. J. R. Parry).

AGRICULTURAL SCIENTISTS' ASSOCIATION OF W.A.

The Agricultural Scientists' Association of Western Australia was formed early in 1934, the first President being Prof. J. W. Paterson, and the Secretary-Treasurer, Mr. G. K. Baron-Hay. At the annual meeting in October, 1934, office-bearers for 1935 were elected as follows: President, Dr. E. J. Underwood; Vice-President, Mr. H. A. Pittman; Hon. Secretary-Treasurer, Mr. G. K. Baron-Hay; Council, Dr. L. J. H. Teakle and Messrs. Shier, Roberts and Williams.

In January, 1935, a farewell luncheon to Prof. J. W. Paterson was given at the Wattle Tea Rooms, Perth. He was presented by the President with an illuminated booklet containing brief biographies of 34 of his old students. Prof. Paterson retired from the Chair of Agriculture in December, 1934, after occupying that position since the inception of the University of W.A. in 1913. Widespread regret was expressed at the loss suffered by the State as a result of his retirement. He left for Great Britain at the end of January, 1935.

Four well-attended meetings of the Association have already been held this year at which papers have been given on "Movements of Soluble Salts in the Soils of the Salmon Gums District," by Mr. G. H. Burvill, B.Sc. (Agric.); "Quality in Wheat," by Mr. G. L. Sutton, Director of Agriculture; "Irrigation in W.A.," by Mr. A. R. C Clifton, and "The Artificial Control of Agricultural Production," by Mr. R. P. Roberts, B.Sc. (Agric.). The meetings were noteworthy for the very spirited discussions which followed the papers.

In June, 1935, Prof. J. E. Nicholls arrived in Western Australia to take up his duties as the new Professor of Agriculture in the University of W.A. The Association takes this opportunity of welcoming him to the State and wishing him every success and happiness in his responsible position.

At present the Association is negotiating in regard to affiliation with the Australian Institute of Agricultural Science.

SULPHUR IN AGRICULTURE.

At the July meeting of the Royal Society of N.S.W., a symposium was held on the subject of Sulphur. Prof. R. D. Watt dealt with the agricultural aspects of the question, referring to the use of sulphur in plant nutrition, in fertiliser manufacture, in insecticides and fungicides, and in connection with soil problems. In reference to animal nutrition, it was stated that sulphur was particularly abundant in wool, hair, hooves, horns, etc. Wool fibre was a complex protein particularly rich in cystine which contained sulphur. The late Prof. Brailsford Robertson was the first to suggest that the cystine content of the sheep's food might be an important limiting factor in the growth of wool, especially in the case of the merino which had a large proportion of wool to carcase. Scoured wool contained about 11 per cent. of cystine, equivalent to about 3.4 per cent. of sulphur, whereas ordinary vegetable proteins rarely had over 1½ per cent. of cystine. Robertson, therefore, initiated experiments along three main lines, viz., (1) the addition of sulphur to soils in the hope that the normal content of cystine in pasture plants might be increased; (2) the introduction of fodder plants naturally rich in cystine; and (3) the use of supplementary foods rich in cystine during droughts and dry spells. Some experiments carried out at Meteor Downs, Queensland, seemed to indicate that proteins rich in cystine, like dried blood, had a greater effect in wool production than ordinary plant protein.

S.U. FACULTY OF AGRICULTURE SILVER JUBILEE.

The twenty-fifth anniversary of the establishment of the Chair of Agriculture at Sydney University was celebrated during August 26-30. During this period the Silver Jubilee of the Faculty of Veterinary Science was also celebrated, the joint conversazione being held in the Great Hall on the 26th at which the Chancellor, Sir Mungo MacCallum, presided. Addresses were given by the Chancellor, the Ministers for Agriculture and Education, and congratulatory messages from overseas and various parts of Australia

were read by the Registrar. On behalf of graduates, undergraduates and friends, Principal Southee presented Professor Watt, Dean of the Faculty of Agriculture, with a handsome cocktail cabinet and a set of golf clubs. The presentation to the Dean of the Faculty of Veterinary Science was made by Dr. Clunies Ross. Other features of the Jubilee were extensive exhibits of work in the Agricultural School; a golf competition for the McWilliam Cup which was won by Mr. C. J. Magee; a golf match between the two faculties, won by Veterinary Science; tennis tournaments; and the Silver Jubilee Agricultural Ball. An official brochure issued by the University contains detailed accounts of the history and development of each Faculty. The success of all events connected with the Faculty of Agriculture celebrations was due to the splendid organisation of the committee, comprising Messrs. J. G. Churchward, E. T. Edwards, and M. V. O'Reilly.

FARRER MEMORIAL, QUEANBEYAN, N.S.W.

A memorial bust to William James Farrer, wheat breeder, was unveiled at Queanbeyan on June 7 by the Governor, Sir Alexander Hore-Ruthven. During the ceremony the Governor sat on an armchair used by Farrer at his old homestead, Lambrigg, in the Federal Capital Territory, a few miles from Queanbeyan and Canberra. The bronze bust, by Rayner Hoff, is set on a sandstone pedestal in a section of the town's main thoroughfare which had been widened, planted with trees and re-named "Farrer Place." A bronze plate bears the words spoken by Farrer when he was told that he had been considered for a knighthood: "I want to think when the end comes, that my life has not been wasted."

It is of interest to note that as a result of representations recently made to the Sydney Municipal Council it has been decided that the area embracing Raphael Street and the small triangular plantation adjoining that street—where the head office of the N.S.W. Department of Agriculture is located—shall be re-named "Farrer Place."

BRISBANE MEETING OF THE INTERNATIONAL SOCIETY OF SUGAR CANE TECHNOLOGISTS.

The International Society of Sugar Cane Technologists held its fourth triennial conference at Brisbane during the last week of August. This was the first occasion on which the Society had held a conference in any country of the British Empire. The arrangements of the conference were largely in the hands of Mr. A. F. Bell, who has acted as Secretary of the Society during the past three years.

The conference was opened on Tuesday, 27th August, by the Governor of Queensland, Sir Leslie Wilson. Delegates attended from all of the principal overseas sugar-producing countries, and their visit has undoubtedly proved most stimulating to those engaged in the technical side of the sugar industry in Australia.

During the business sessions of the Congress, papers were presented covering various aspects of the genetics, pathology, entomology and cultivation of sugar cane, as well as of sugar manufacture. In addition, reports were submitted by special committees on identification and description of the original cane varieties; soil studies; and the technique of field experiments.

At the conclusion of the conference, overseas delegates were conducted on a tour of the sugar districts of North Queensland as guests of the State Government, the itinerary including visits to Bundaberg, Mackay, Ayr, Innisfail, Cairns and the Atherton Tableland. Highly commendatory opinions regarding the organisation and efficiency of the sugar industry in Queensland were expressed by those taking part in the tour.

PERSONAL NOTES

CANBERRA, F.C.T.

Dr. A. E. V. Richardson, President of the Institute, visited Canberra on May 30th. He met the local branch of the Institute in the afternoon, and gave the members an interesting address on plant immigrants, desirable and otherwise.

Mr. A. B. Cashmore has been transferred from the Division of Animal Nutrition, C.S.I.R., to the Division of Plant Industry at Canberra. He will be working on the control of noxious weeds.

Mr. R. V. Fyfe has now been appointed to a permanent position in the Noxious Weeds Section of the Division of Economic Entomology. He sailed for Fiji on July 24th to study the Lantana bug to determine if it can be introduced, with safety, into Australia for the control of Lantana.

Miss F. E. Allan, biometrician, of the Division of Plant Industry, visited Merbein recently to help the staff there with statistical data.

NEW SOUTH WALES.

Mr. W. S. Campbell, Director of Forests and Agriculture in N.S.W. from 1903 to 1909, died on July 25 at the age of 91. It was mainly due to Mr. Campbell's efforts that the Government Experiment Farms were established in N.S.W.

Professors R. D. Watt and J. D. Stewart, Deans of the Faculties of Agriculture and Veterinary Science respectively at Sydney University, have been elected to Honorary Life Membership in the Royal Agricultural Society of N.S.W., in recognition of services rendered to the State.

Mr. N. H. Parbery has been admitted to the M.Sc. Agr. degree, Sydney, for a thesis on "Studies of Certain Soil Profiles of the South Coast of N.S.W."

Mr. F. T. Bowman, Ben Fuller Travelling Scholar, sailed by the "Monterey" on July 24 for U.S.A. He will spend eighteen months at the Agricultural Experiment Station, Davis, Cal., and will then visit other horticultural centres in America before undertaking work at the East Malling Station, England. Attention will be devoted largely to problems of fruit setting.

Messrs. A. H. E. McDonald, Director of Agriculture, and C. G. Savage, Director of Fruit Culture, recently visited Norfolk Island in connection with official business.

Mr. W. Poggendorff sailed by the "Mariposa" on August 21 for U.S.A., where he will investigate problems connected with the rice industry. The Chairman of the Rice Marketing Board also sailed by the same boat.

Mr. G. de V. Davis is continuing his inquiries into various aspects of the fertiliser industry abroad, and is expected to return in December. He attended the Royal Garden Party at Buckingham Palace in July.

Recent visitors included Mr. H. A. Pittman of the W.A. Department of Agriculture, and Mr. A. P. D. McClean, Mycologist of the South African Department of Agriculture. Mr. McClean attended the triennial International Sugar Conference at Brisbane in August; he addressed members of the Biological Branch of the State Department in Sydney on his researches into virus diseases.

VICTORIA.

Mr. J. Brake has been made chairman of a committee appointed by the Government to inquire into the position of the tobacco growing industry in Victoria, and to recommend what form of assistance, if any, should be given to growers. Mr. J. Keane, Agricultural Economics Officer, was appointed to assist the committee.

During the period 31st July to 2nd August, a conference on codling moth problems was held in Melbourne and was attended by Messrs. F. M. Read and R. T. M. Pescott (Vic.), R. Veitch and H. Barnes (Queensland), A. G. Strickland (South Australia), J. W. Evans and P. H. Thomas (Tasmania), and S. L. Allman (New South Wales).

Mr. G. Loftus-Hills, who has completed his studies at the National Institute for Research in Dairying, Reading, and who subsequently visited dairy research institutes at Copenhagen, Kiel, Leipsig, Vienna and Moscow, is now studying at Iowa, U.S.A., under Dr. Hammer.

Recent appointments include Mr. A. Morgan as Irrigation Field Officer, and Mr. L. R. Scharp as Dairy Technologist, both to the State Department.

SOUTH AUSTRALIA.

Professor J. A. Prescott spent a month in Western Australia in July-August with officers of the Departments of Agriculture and Forestry, in connection with soil problems.

Mr. W. J. Spafford, Deputy Director of Agriculture, recently returned from a visit of agricultural inquiry to exporting countries of the Southern Hemisphere, including New Zealand, the Argentine, and South Africa. With Mr. Spafford was Col. C. P. Butler of "The Advertiser," Adelaide.

Messrs. J. K. Taylor and P. D. Hooper are at present engaged on work at Leeton, in the Murrumbidgee Irrigation Area, N.S.W.

Mr. C. N. Ratcliffe, Biologist of the C.S.I.R., recently spent a week at the Waite Institute prior to his commencing an investigation of the causes of soil drift in the northern pastoral areas of South Australia.

Mr. C. G. Stephens arrived at the Waite Institute from Hobart towards the end of June and has been making some detailed inquiries into the nature of the soils from a particular area near Burnie, Tasmania, following the completion of field work.

Mr. A. L. Tisdall of Merbein, Victoria, is spending a period of six months at the Waite Institute in connection with the examination of vineyard soils of the Murray Irrigation Areas in Victoria and South Australia.

Mr. T. H. Strong, formerly of the Queensland Faculty of Agriculture, was recently appointed Bacteriologist of the Soils Division, C.S.I.R., and has commenced work at the Waite Institute in connection with the root nodule organisms of leguminous pasture plants.

Mr. H. G. Andrewartha, an officer of the C.S.I.R., who has been engaged on investigations of the life history and ecology of thrips, together with Mrs. Andrewartha, at the School of Agriculture, Melbourne, has been transferred to the Waite Institute.

Recent visitors to the Waite Institute included the Federal Cabinet on 3rd July, Messrs. H. A. Pittman and Sharp of the Western Australian Department of Agriculture and Mr. J. F. Kennedy, of Australian Estates and Mortgage Co. Ltd., Queensland.

QUEENSLAND.

Mr. R. E. Milner Clarkson, who, since graduation, has been engaged on soils investigations for sugar estates in North Queensland, has been appointed to undertake similar work in the Cotton section of the Department of Agriculture and Stock.

Mr. C. J. McKeon has been appointed Director of Tropical Agriculture in the Department of Agriculture and Stock, and will be in charge of the Research Station which is to be established at South Johnstone, North Queensland.

Mr. R. E. Mungomery, Entomologist of the Bureau of Sugar Experiment Stations, recently visited Hawaii for the purpose of supervising the transport to Queensland of a shipment of the giant toads which are proving so effective in cane pest destruction in that and other sugar countries.

TASMANIA.

Mr. C. G. Stephens, Assistant Research Officer, C.S.I.R., has been on the North Coast for some months making a survey of the basalt soils. In this work he is consulting with the District Agricultural Officers in regard to local information.

Mr. E. F. Fricke, previously stationed at Devonport, has been appointed Agronomist and is now located at Launceston.

Mr. J. O. Henrick on a recent visit to Sydney made contact with the Editor of the Journal, and brought back information on various aspects of the future development of the Institute.